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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 4 : B63H 9/06, B29C 33/42, 39/02 B29C 41/02, 41/12 — A1

(11) International Publication Number: WO 87/ 07233

(43) International Publication Date: 3 December 1987 (03.12.87)

(21) International Application Number: PCT/AU87/00144

(22) International Filing Date: 21 May 1987 (21.05.87)

(31) Priority Application Number: PH 6010

(32) Priority Date: 21 May 1986 (21.05.86)

(33) Priority Country: AU

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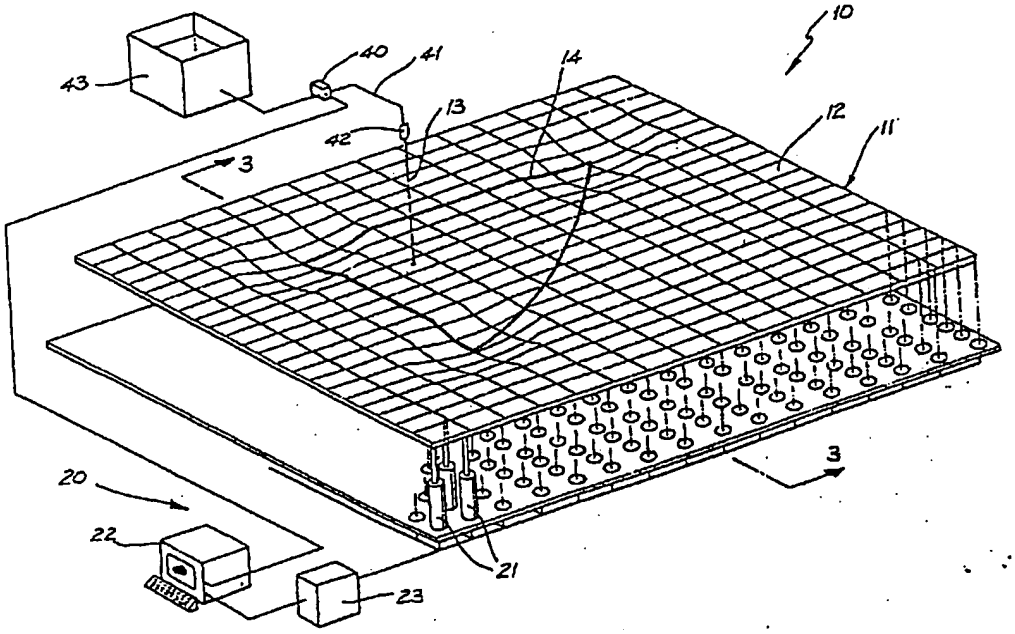
(81) Designated States: AT (European patent), BE (European patent), BR, CH (European patent), DE (European patent), DK, FR (European patent), GB (European patent), IT (European patent), JP, LU (European patent), NL (European patent), SE (European patent), US.

Published
With international search report.

(54) Title: METHOD AND APPARATUS FOR FORMING OF SAILS



(57) Abstract

A method and apparatus for formation of sails from a liquid distributed over a mould (10). The mould (10) is essentially a flat surface deformable according to a three dimensional design from which a computer (22) controls the final shape. The apparatus can also be used for production of solid articles having complex curvaceous configurations.

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"METHOD AND APPARATUS FOR FORMING OF SAILS"

TECHNICAL FIELD

The present invention relates to sails and in particular to a method of making sails which are formed primarily in one piece.

The known method of making sails is to take lengths of woven or plastic sheet material, and cut them into configurations so that when sewn together there is provided the aerofoil shape which is necessary to propel the boat. In order to attach a sail to the boat it is generally suspended from a mast by a connection at its head. The clew and tack, representing the other two corners complete the basic attachment. Eyelets are located in the head, clew and tack of the sail. The eyelets are points of high stress concentration and the sail must be heavily reinforced about the areas in which the eyelets are located with several layers of material. Each layer being individually sewn onto the sail in an increasing radial area. Further the luff and foot of a mainsail is usually reinforced and include a bolt rope which secures the luff and foot of the sail to the mast and boom respectively in a continuous manner. This method of constructing sails is labour intensive and thus expensive. Also, it is extremely difficult to reproduce the same sail dimensions and aerofoil shape due mainly to the human factor.

A number of attempts at manufacturing sails from a single piece of polymeric woven or unwoven material have been proposed such as in German patent P3119734.5 (Scopinich); European patent application 82100412.4 (North sails); and German patent P3101796.7 (North sails).

These prior art proposals primarily require a preformed male and/or female mould over which a flat laminated or standard film is either stretched or simply laid, and then formed permanently to the shape of the mould by the application of heat and/or pressure. It is understood that none of these methods have achieved any degree of success and in any event suffer from the necessity of having a pre-made mold which cannot be adjusted for bearing aerofoil shapes and peripheral dimensions. These inventions also require substantial labour involvement and the addition of reinforcing pieces to be added as separate steps where required.

The design of sail shapes using computer programs to produce 3 dimensional models is now in common use. Once the dimensions of a sail are decided and the aerofoil profile determined the computer can be used to drive a large scale plotter which marks out the necessary cutting lines on the lengths of the material which are then sewn together. Some plotters

will actually cut the cloth at the same time. Accordingly it is an object of the present invention to overcome or substantially ameliorate the abovementioned disadvantages.

DISCLOSURE OF THE INVENTION

There is disclosed herein forming apparatus to produce a formed film wherein said apparatus comprises:

a flexible forming bed having an upper surface which is capable of being manipulated from a flat surface to form a smooth curved three dimensional surface, wherein said bed may simultaneously have different areas of convex and concave curvature;

manipulation means adapted to vary the shape of the bed surface, said manipulation means comprising a plurality of bed adjustment means which are attached to the underside of the bed;

said plurality of table manipulation means arranged in a matrix, each table level adjustment means being capable of manipulating a localized section of the forming table;

the apparatus further comprising a computer operated control system adapted to control and operate said manipulation means, wherein said control system may operate said manipulation means and hence produce substantially any desired shape with the surface of forming table.

There is further disclosed herein a method of producing a formed film wherein:

a forming liquid is poured onto an upper surface of a forming table, wherein said forming table is manipulated into a desired first shape by a manipulation means; wherein the liquid, by virtue of its viscosity, a predetermined volume, and confinement means to restrict the flow of said forming liquid, is allowed to form into a predetermined film thickness and shape;

gelling the liquid; distorting the upper surface of the table to a predetermined shape;

curing the gel to a set state and removing the set article.

BRIEF DESCRIPTION OF THE DRAWINGS

A preferred form of the present invention will now be described by way of example with reference to the accompanying drawings, wherein:

Figure 1 is a schematic perspective view of the film forming apparatus, showing one configuration of the forming table;

Figure 2 is an enlarged schematic perspective view of of a further confiruration of the forming table of the film forming apparatus of

Figure 1; and

Figure 3 is an enlarged schematic sectional view of the film forming apparatus of Figure 1.

MODES FOR CARRYING OUT THE INVENTION

In the accompanying drawings there is schematically depicted a film forming apparatus 10 comprising a forming table 11 and manipulation means 20.

The forming table 11, is preferably a flexible material capable of being manipulated into the desired degrees of curvature without experiencing plastic deformation. The upper surface 12 of the forming table is preferably very smooth (i.e. with low surface friction) to allow a synthetic forming liquid 13 to flow freely. The table may also be formed of a composite structure having say a compressible, flexible material on the underside affixed to a flexible material forming the upper surface.

The manipulation means 20 comprises a plurality of level adjustment means, for example, hydraulic rams 21, are slidably attached to, and support, the forming table 11. Each hydraulic ram 21 is connected to a computer operated control system 22, 23 through a control loop, wherein each ram 21 is capable of being accurately positioned with reference to a datum plane. The computer 22 wherein the three dimensional desired shape is stored, determines what position each ram 21 should assume, the control system 23 operates each ram 21 to move to the required position, and hence the flexible forming table 11 may be manipulated into substantially any desired shape. The hydraulic control of the rams may of course be replace by worn drive adjustment means or other equivalent systems.

The computer can also determine the volume of liquid necessary to provide the desired resultant film thickness. This calculation can then be used to control a metering pump 40 which feeds 41 a liquid dispenser 42 from reservoir 43. Generally, a multi-nozzled distributor is used to ensure a uniform distribution of the liquid.

The operating procedure of this apparatus is as follows:

The forming table 11 is manipulated by the manipulation means 20 into a substantially flat shape whereupon a synthetic forming liquid 13 is poured onto the forming table and allowed to flow and form a "pool" by virtue of a confinement means 14 which provides a "wall" to stop the flow of liquid and confine the shape of the liquid film generally to the desired sail shape. The amount of forming liquid 13 poured onto the forming membrane 11 is predetermined so as to produce the desired film thickness.

Note, the manipulation 20 means is able to shape the forming membrane so that some areas of the sail have increased film thickness to provide the required varied strength characteristics of different areas of the finished sail as shown in Figs 1 and 3. These areas are typically at the clews, luff, lech and foot.

When the forming liquid is in the required shape and film thickness, it is then caused to become a gel (i.e. high viscosity fluid). The computer operated control system then operates the hydraulic rams 21 to manipulate the forming table, and hence the gel film, into the desired shape of the sail. The gel film may then be cured (or set) whereupon a formed film of the synthetic material is produced.

This apparatus provides a means for manufacturing a improved type of sail, wherein the strength characteristics of the formed film material are multi-directional, and does not require the time consuming and costly operations involved in making a correctly shaped sail from conventional material. This apparatus is also capable of forming areas on the sail where the film thickness is increased. These areas can include areas where a sail experiences high stress, and in areas where it is required for the sail be self supporting, that is, an areas of increased film thickness may be provided and positioned in such a way to have the same strengthening effect as batterns have in a conventional woven material sail. Alternately, additional pre-formed materials such as "Kevlar" reinforcing strips or batterns can be laid in the mould at the desired position prior to gelling of the liquid.

Selection of the liquid to be used depends upon a number of considerations, many of which relate to using the least expensive formulation which has the necessary strength and durability to achieve the desired result. Generally, the selection would be made from that group of compounds based on polyurethane polymers. The preferred ones would be those wherein the cross-linking of the polymer can be delayed until it is activated by controlled means such as heat or ultra-violet or infra-red radiation.

Therefore, the method, apparatus, and product of the above described embodiment produces an improved sail, and greatly reduces the time and labour involvement in producing this improved of sail when compared to a conventional woven material sail and the method of producing such a sail.

The one apparatus can quickly be altered to accommodate different sizes and cross-sectional shapes enabling the mass production of a wide

variety of sails.

It will also be clear that this apparatus can be used to form not only flexible items such as sails but rigid or semi-rigid curved panels from resinous materials, fibre-glass type materials or other plastics.

CLAIMS

1. Apparatus to produce a formed film wherein said apparatus comprises:

a flexible forming bed having an upper surface which is capable of being manipulated from a flat surface to form a smooth curved three dimensional surface, wherein said bed may simultaneously have different areas of convex and concave curvature;

manipulation means adapted to vary the shape of the bed surface, said manipulation means comprising a plurality of bed adjustment means which are attached to the underside of the bed;

said plurality of table manipulation means arranged in a matrix, each table level adjustment means being capable of manipulating a localized section of the forming table;

the apparatus further comprising a computer operated control system adapted to control and operate said manipulation means, wherein said control system may operate said manipulation means and hence produce substantially any desired shape with the surface of forming table.

2. A method of producing a formed film wherein:

a forming liquid is poured onto an upper surface of a forming table, wherein said forming table is manipulated into a desired first shape by a manipulation means; wherein the liquid, by virtue of its viscosity, a predetermined volume, and confinement means to restrict the flow of said forming liquid, is allowed to form into a predetermined film thickness and shape;

gelling the liquid; distorting the upper surface of the table to a predetermined shape;

curing the gel to a set state and removing the set article.

3. The method of claim 2 wherein the liquid is a delayed cross-linking polyurethane polymer.

4. The method of claim 2 or 3 wherein pre-formed solids material is placed within the mould at predetermined positions.

5. The method of claim 1 wherein the final curing is achieved by application of heat or radiation.

6. An article made in accordance with any one of claims 2 to 5.

7. An article as claimed in claim 6 wherein the article is a sail.

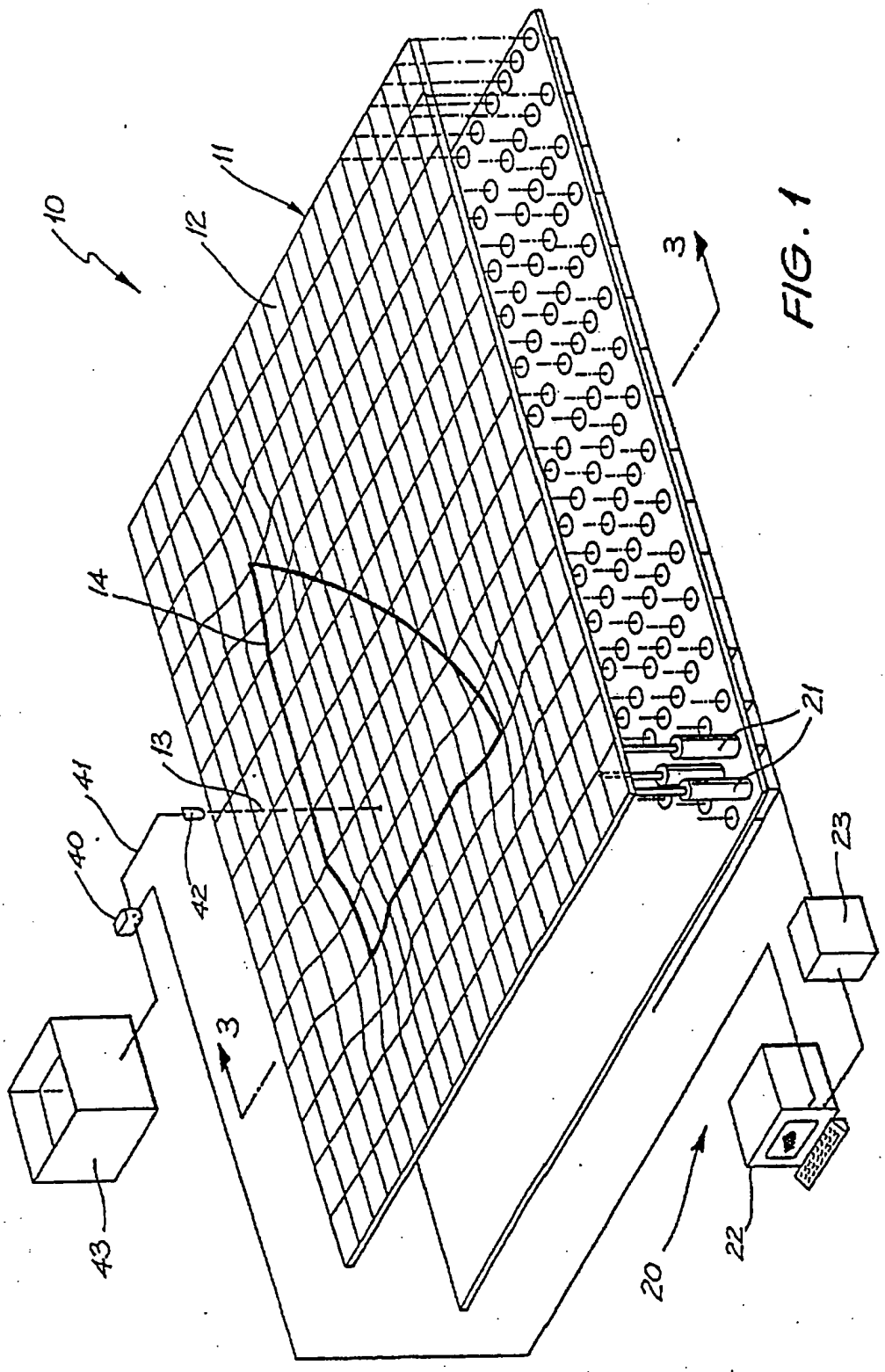

FIG. 1

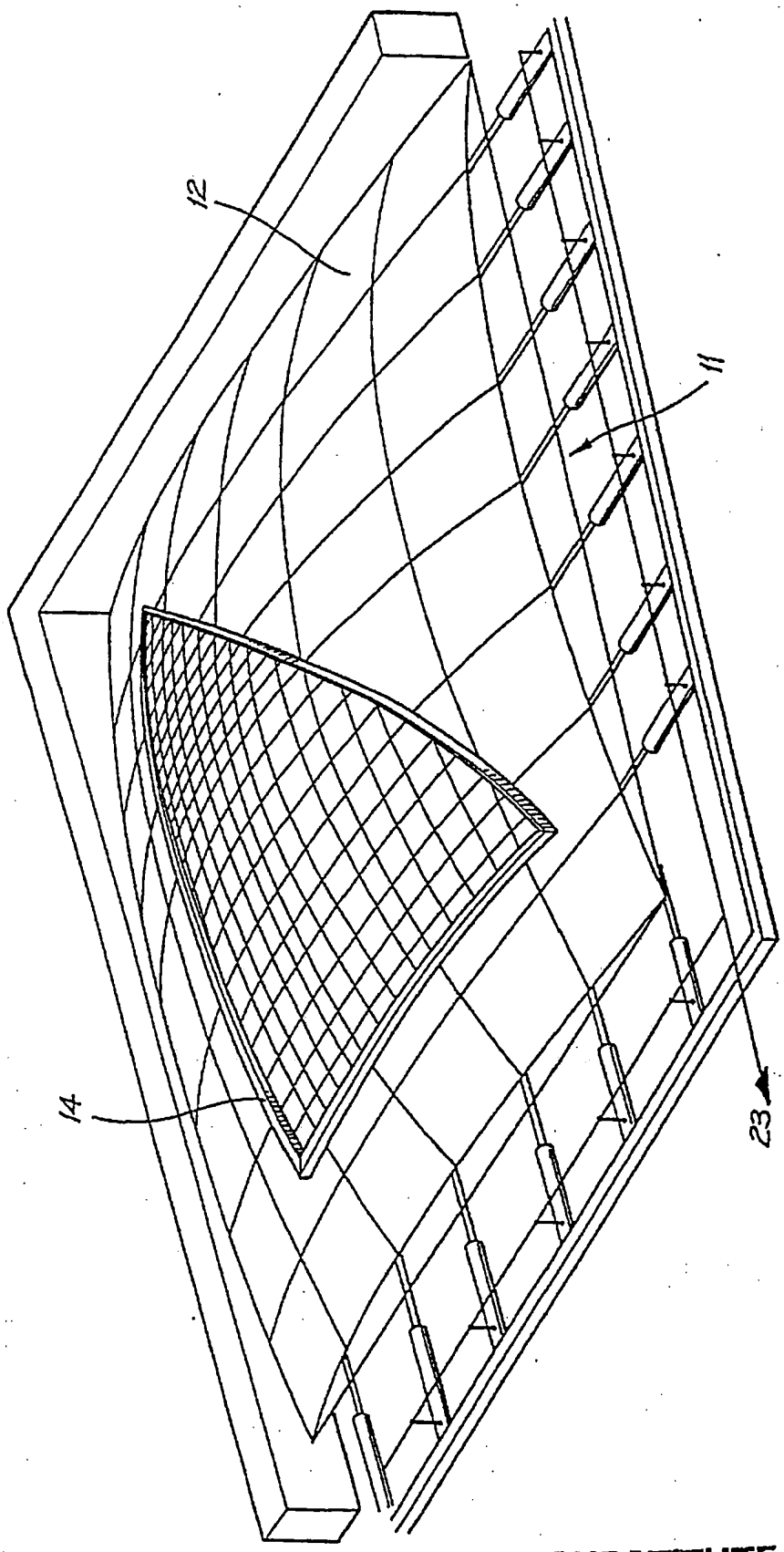

FIG. 2

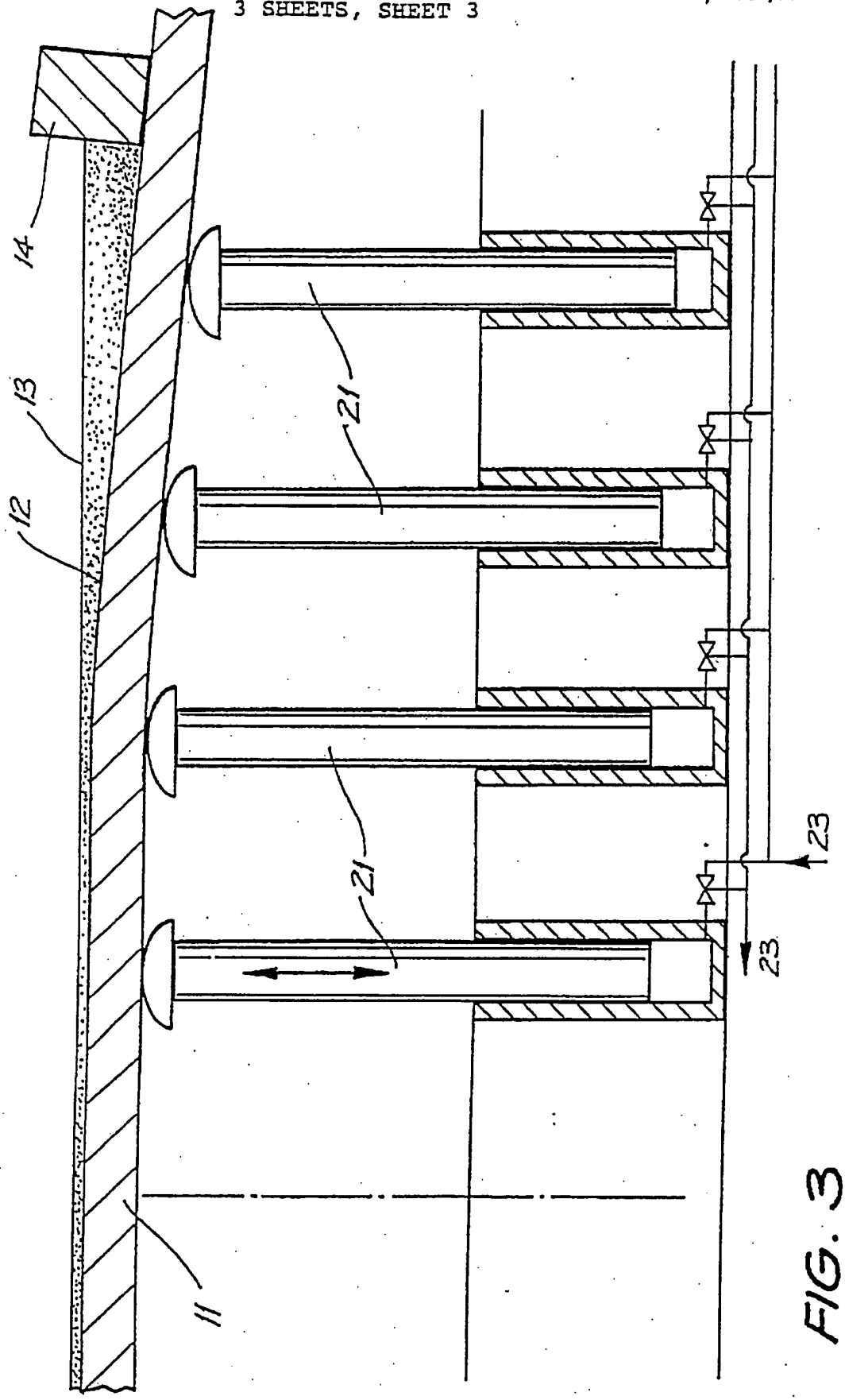

FIG. 3

INTERNATIONAL SEARCH REPORT

International Application No PCT/AU 87/00144

I. CLASSIFICATION OF SUBJECT MATTER

According to International Patent Classification (IPC) or to both National Classification and IPC

Int Cl[4] B63H9/06, B29C33/42, 39/02, 41/02, 41/12

II. FIELDS SEARCHED

Minimum Documentation Searched

Classification System	Classification Symbols
IPC[3,4]	B29C 1/00, 5/00, 23/00, B29D 7/08
IPC[4]	B63H 9/06, B29C 33/42, 39/02, 41/02, 41/12

Documentation Searched other than Minimum Documentation to the Extent that such Documents are included in the Fields Searched

AU : IPC as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
A	AU,A 79654/82 (NORTH SAILS SURF ANTILLES W.V.) 29 July 1982 (29.07.82) (& EP,A, 56657, & DE,A, 3101796).	
A	DE,A, 3119734 (SCOPINICH) 2 December 1982 (02.12.82)	
A	AU,B, 41088/78 (526435) (LE COMMISSARIAT A L'ENERGIE ATOMIQUE AND BFG GLASSGROUP) 13 January 1983 (13.01.83)	
Y	US,A, 4309824 (FUCHS) 12 January 1982 (12.01.82) (& GB,A, 2014927 & EP,A, 3807)	(1)
Y	FR,A, 2548577 (SOCIETE DE CONSTRUCTION DES AVIONS HUREL-DUBOIS) 11 January 1985 (11.01.85)	(1,2,6,7)
A	DE,A, 2926476 (SEYSSEL D'AIX) 22 January 1981 (22.01.81)	

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
10 September 1987 (10.09.87)	(15.09.87) 15 SEPTEMBER 1987
International Searching Authority	**Signature of Authorized Officer**
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Form PCT/ISA/210 (second sheet) (January 1985)

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON
INTERNATIONAL APPLICATION NO. PCT/AU 87/00144

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report	Patent Family Members			
AU 79654/82	DE 3101796	EP 56657	JP 57144189	
US 4309824	CH 639333 EP 3807	DE 2807954 GB 2014927	DK 783/79 NL 7901410	
AU 41088/85	JP 60243108	US 4525232		

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